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(54) RING-SHAPED SPRING AND METHOD FOR MANUFACTURING SAME

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Description

Technical Field

[0001] The present invention relates to a ring spring, such as a disk spring or a wave spring, and relates to a method for producing the same.

Background Art

[0002] The ring spring, such as a disk spring and a wave spring, has been used for absorbing shocks that occur during engaging a clutch in a clutch device in transportation equipment, for example. In a conventional method for producing the ring spring, a blank having approximately a ring shape has been punched out of a tabular material by pressing processing; however, in this method, the yield ratio of the material was poor. As a method to improve the yield ratio of the material, a method is known in which edge parts of material formed in a ring shape by bending formation are welded (see Japanese Unexamined Patent Application Publications Nos. Hei 06 (1994)-106277 and 2001-225112).

[0003] In a method for producing disk spring, in the case in which edge parts of the material are welded, a process shown in Fig. 4 is employed, for example. First, material is prepared (step S11), the material is formed in approximately a ring shape by bending formation (step S12), and the edge parts of the approximately ring shape material are mutually welded (step S13). According to this method, ring material having no edge can be obtained. Next, the ring material is processed to a disk shape (approximately cone shape) by cold forming (disk forming) so as to obtain disk spring material (step S14). Subsequently, by performing quenching and tempering of the disk spring material (steps S15 and S16) so as to obtain the disk spring.

[0004] However, in the method in which the edge parts of the raw material are welded, the welded part of the material becomes a welded metal part, and a circumferential part thereof becomes a welded heat-affected zone that is affected by heating during welding. In this case, since a hardened region is formed at the welded metal part and a softened region is formed at the welded heat-affected zone, in order to keep strength necessary as a disk spring, it is necessary that quenching and tempering be performed on the disk spring material after cold forming. Thus, since quenching and tempering are required and thereby increase the number of processes, production cost may be increased and the product may be expensive.

[0005] US 2011/0006467 A1 discloses a disc spring formed out of a metal strip, which is bent to form a ring and having end parts, which are connected by means of electron beam welding.

[0006] US 6,206,984 B1 discloses a non-heat treated wire or bar steel for springs, which have in its as-rolled state a tensile strength of 120-150 kgf/mm^2 and a bending breakage rate no higher than 15%. The composition of this wire or bar steel comprises Nb: 0.005-0.15 wt%, Ti: 0.01-0.1 wt%, B: 0.0005-0.01% wt%, Cr: 1.02-1.8 wt%, as well as more than 0% aluminum and Fe.

[0007] DE 20 2011 002 271 U1 discloses a wave-shaped spring washer, which is formed by welding two edges of a raw material. The welding line is provided in an area of low stresses.

[0008] Therefore, an object of the present invention is to provide an inexpensive ring spring having high strength and a method for producing the same.

Summary of the Invention

[0009] The ring spring of the present invention is a ring spring which is formed to have no edge by welding both edges of raw material, and has a welded metal part which is formed at interface part of the both edges of the raw material, and a welded heat-affected zone which is formed circumference of the welded metal part and which is heated by welding, and the ring spring has a tensile strength of 1000 MPa or more and a composition as defined in the appended claim 1.

[0010] Since the ring spring of the present invention is obtained by welding the two edge parts of the raw material, the ring spring has the welded metal part and the welded heat-affected zone. In this case, the ring spring has tensile strength of 1000 MPa or more in a condition in which it has the welded metal part and the welded heat-affected zone, which is a sufficient tensile strength for a disk spring and a wave spring for example, and therefore, quenching and tempering are not necessary. Therefore, material yield is improved and material cost is reduced compared to a conventional method in which a blank having a ring shape is punched out by pressing processing, and in addition, production cost can be further reduced since one of a production process can be omitted compared to a conventional method in which edge parts of the material are welded. As a result, price of the product can be reduced. Furthermore, since quenching and tempering are not performed, the product can be prevented from being deformed, thereby improving dimensional accuracy of the product.

[0011] Various constructions can be employed as the ring spring of the present invention. With respect to chemical components, the content of C should be decreased since a larger content of C may cause formation of a quenching hardened layer and decrease of toughness. However, in the case in which content of C is reduced, since strength may be decreased, it may be necessary to increase strength by action of solid-solution strengthening and miniaturization of crystal particles or the like, brought by adding an element other than C.

[0012] In this case, the chemical components of the raw material consist of C: 0.10 to 0.30 mass%, Si: 0.50 to 2.10 mass%, Cr: 0.50 to 1.50 mass%, Mn: 1.0 to 2.0 mass%, P: 0.025 mass% or less, S: 0.025 mass% or less, Fe as a remainder and inevitable impurities.

[0013] Hereinafter, basis for the above numeric limitation of each element is explained. It should be noted that "%" always means "mass%" in the following explanation.

C: 0.10 to 0.30 %

[0014] C is an important element to maintain strength of the welded part. Strength of the welded part may be insufficient in a case in which content of C is less than 0.10 %. On the other hand, in a case in which content of C is more than 0.30 %, a hardened structure such as martensite or the like is increased, a quenched hardened layer is formed, and toughness is decreased. Therefore, in order to improve strength of the welded part and toughness, content of C is set within 0.10 to 0.30 %.

Si: 0.50 to 2.10 %

[0015] Si is an important element to maintain strength of the welded part as an element to strengthen solid solution. Strength of the welded part may be insufficient in a case in which content of Si is less than 0.50 %. On the other hand, in a case in which content of Si is more than 2.10 %, the effect of maintaining strength may be saturated and properties of welding may be degraded. Therefore, in order to improve strength of the welded part and property of welding, content of Si is set within 0.50 to 2.10 %.

Cr: 0.50 to 1.50 %

[0016] Cr is an effective element to increase strength of the welded part. Strength of the welded part may be insufficient in a case in which the content of C is less than 0.50 %. On the other hand, in a case in which the content of C is more than 1.50 %, toughness is decreased. Therefore, in order to improve strength of the welded part and toughness, the content of Cr is set within 0.50 to 1.50 %.

Mn: 1.0 to 2.0 %

[0017] Mn is an effective element to prevent hot brittleness by S, in addition to improve strength as an element to strengthen a solid solution. Strength may be insufficient in a case in which the content of Mn is less than 1.0 %. On the other hand, in a case in which the content of Mn is more than 2.0 %, workability is decreased. Therefore, in order to improve strength and workability, the content of Mn is set within 1.0 to 2.0 %.

P: 0.025 % or less

[0018] It is desirable that the content of P be as low as possible, since a high content of P may cause deterioration of workability and welding property. The P content of 0.025 % or less can be acceptable in order to maintain workability and welding property in a ring spring.

S: 0.025 % or less

[0019] It is desirable that the content of S be as low as possible, since a high content of S may cause deterioration of ductility. The S content of 0.025 % or less can be acceptable in order to maintain ductility in a ring spring.

[0020] With respect to chemical components of the material of the ring spring of the present invention, in order to effectively obtain the above effects by C, Cr and Mn, more desirable ranges are as follows. That is, an embodiment with a raw material consisting of C: 0.15 to 0.25 mass%, Si: 0.50 to 2.10 mass%, Cr: 0.8 to 1.1 mass%, Mn: 1.3 to 1.7 mass%, P: 0.025 mass% or less, S: 0.025 mass% or less, Fe as a remainder and inevitable impurities is more desirable.

[0021] In addition, but not forming part of the invention, in order to further improve strength of the welded metal part and toughness, at least one of Ni, Mo, Ti, V and Nb can be added.

[0022] As a raw material, a steel material having carbon equivalent Ceq shown by below formula (1) of 0.5 to 0.75 mass% and hardness of 350 HV or more can be used, and the steel material can contain C: 0.30 mass% or less. It should be noted that in the formula (1), "[ ]" means content (mass%) of each element.

$$Ceq = [C] + [Mn] / 6 + [Si] / 24 + [Ni] / 40 + [Cr] / 5 + [Mo] / 4 + [V] / 14 \ldots(1)$$

[0023] In a case in which carbon equivalent Ceq is less than 0.5 mass%, strength that is required for a ring spring cannot be maintained, and in a case in which Ceq is more than 0.75 mass%, hardness of the welded metal part may be too large and toughness may be decreased. Therefore, in order to effectively realize maintaining of strength and improvement of toughness required for a ring spring, the carbon equivalent Ceq is set from 0.5 to 0.75 mass%. Furthermore, by limiting the hardness of the raw material (master material) at 350 HV or more, strength that is required for a material after welding can be effectively obtained.

[0024] There may be a case in which shrinkage, possibly caused by stress concentration, occurs at the welded metal part, and the shrinkage is unlikely to occur at the welding start part and is likely to occur at the welding end part. Therefore, it is desirable that the welding start part of the welded metal part be formed at one of an outer circumferential part or inner circumferential part having higher tensile stress.

[0025] As a ring spring, for example, a disk spring having a disk shape or a wave spring having a wavy shape consisting of a mountain part and a valley part can be mentioned. In the case in which the wave spring is used, it is desirable that the mountain part and the valley part, at which stress generation peaks, be formed at a position different from the welded metal part.

[0026] A method for producing ring spring of the present invention includes steps of: a bending forming process in which raw material is formed in approximately a ring shape by bending forming, a welding process in which edge parts of the raw material of the approximately ring shape are mutually welded so as to obtain a raw material ring having no edge, in which in the welding process, a welded metal part is formed at an interface of the two edge parts of the raw material, and welded heat-affected zone which is heated by welding is formed around the welded metal part, and in which the ring spring has tensile strength of 1000 MPa or more and a composition as defined in the appended claim 1.

[0027] According to the method for producing the ring spring of the present invention, a ring spring having the above effects can be produced.

[0028] According to the ring spring or the method for producing the same of the present invention, the product can be strengthened and the cost can be reduced at the same time.

Brief Description of Drawings

[0029]

Fig. 1 is a flow chart diagram showing the production processes of the method for producing the ring spring of one Embodiment of the present invention.

Figs. 2A and 2B are conceptual diagrams showing a desirable example of welding in the method for producing the ring spring of one Embodiment of the present invention.

Fig. 3 is a part of a development diagram showing a side view of skeleton framework of a practical example of the wave spring as a ring spring of one Embodiment of the present invention.

Fig. 4 is a flow chart diagram showing the production processes of a conventional method for producing the ring spring.

Explanation of Reference Numerals

[0030] 1A, 1B: Raw material ring having no edge, 2: wave spring, 11: outer circumferential part, 12: inner circumferential part, 13, 33: welded metal part, 21: convex part, 31: mountain part, 32: valley part.

Best Mode for Carrying Out the Invention

[0031] Hereinafter, an Embodiment of the present invention is explained with reference to the drawings. Fig. 1 is the flow chart diagram showing the production processes of the method for producing the ring spring of one Embodiment of the present invention. In this Embodiment, as shown in Fig. 1 for example, raw material preparation (step S1), bending formation (step S2), welding (step S3), disk formation (step S4), and low-temperature annealing (step S5) are performed in this order.

[0032] First, the raw material is prepared (step S1). As the raw material, a material that has tensile strength of 1000 MPa or more in a condition in which the ring spring obtained from the raw material has a welded metal part and a welded heat-affected zone, is used.

[0033] As the raw material, steel material having carbon equivalent Ceq shown by the below formula (1) of 0.5 to 0.75

mass% and hardness of 350 HV or more is used. It should be noted that "[ ]" means content amount of each element (mass%) in the formula (1).

$$Ceq = [C] + [Mn] / 6 + [Si] / 24 + [Ni] / 40 + [Cr] / 5 + [Mo] / 4 + [V] / 14 \ldots(1)$$

[0034] With respect to the practical chemical composition, the raw material consists of C: 0.10 to 0.30 mass%, Si: 0.50 to 2.10 mass%, Cr: 0.50 to 1.50 mass%, Mn: 1.0 to 2.0 mass%, P: 0.025 mass% or less, S: 0.025 mass% or less, Fe as the remainder and inevitable impurities. With respect to C, Cr, and Mn, more desirable content amounts are C: 0.15 to 0.25 mass%, Cr: 0.8 to 1.1 mass%, and Mn: 1.3 to 1.7 mass%.

[0035] The raw material can be obtained for example, a material which is austenitized and then rapid-cooled, a material which is austenitized and then austempering-treated, or a material which is austenitized and then patenting-treated, is processed by wire drawing. As a structure of the raw material, wire material, tabular material, strip material or the like is used. In this case, kinds of structure such as elongated material, hoop material, coil material, and fixed scale material can be used. As a cross-sectional shape of the raw material, it is not limited only to a square cross section, and other cross section such as trapezoid, ellipse or the like can be employed.

[0036] Next, by forming the raw material in a ring shape by bending formation, the raw material ring is obtained (step S2). In this case, for example, by facing edge surfaces of the two edge parts of the raw material each other, the facing part is formed. It should be noted that the raw material can be formed as a raw material ring having a disk shape (approximately cone shape) by performing disk formation and bending formation at the same time. Furthermore, by performing wave shape formation instead of disk formation, a raw material ring having wavy shape consisting of mountain part and valley part can be made. In these cases, following disk formation or wavy shape formation of step S4 can be omitted.

[0037] Next, the facing part of the raw material ring is welded thereby obtaining the raw material ring having no edge (step S3). The raw material ring having no edge has the welded metal part that is formed at an interface of two edge parts of the raw material, and the welded heat-affected zone that is formed around the welded metal part and is heated during welding. Various methods can be employed as the welding method, and it is not limited in particular, but a laser welding is desirable. In the laser welding, since the emission spot is small, formation of the welded heat-affected zone can be reduced. A convex bead formed on the welded metal part can be removed if necessary.

[0038] In a case in which the disk spring is produced, for example, at a concave surface side in which tensile stress occurs during elastic deformation in order to lower the height along an axis line direction, it can be designed so that tensile stress of the outer circumferential part is higher than that of the inner circumferential part, or so that tensile stress of the inner circumferential part is higher than that of the outer circumferential part. In this case, it is desirable that the welding direction be determined as follows in view of the possibility of the occurrence of shrinkage by welding.

[0039] Fig. 2A shows a raw material ring 1A that is used as a raw material of a disk spring in which tensile stress of outer circumferential part 11 is set higher than that of inner circumferential part 12. In the raw material ring 1A, when welding is performed along a direction (arrow line direction) from the outer circumferential part 11 to the inner circumferential part 12, welded metal part 13 is formed at facing part. In this case, shrinkage occurs at the inner circumferential part 12 in which tensile stress is low, thereby forming concave part 21, and the concave part is not formed at the outer circumferential part 11 having high tensile stress. Fig. 2B shows a raw material ring 1B that is used as a raw material of a disk spring in which tensile stress of inner circumferential part 12 is set higher than that of outer circumferential part 11. In the raw material ring 1B, when welding is performed along a direction (arrow line direction) from the inner circumferential part 12 to the outer circumferential part 11, shrinkage occurs at the outer circumferential part 11 in which tensile stress is low, thereby forming concave part 21, and concave part is not formed at the inner circumferential part 12 having high tensile stress. In this way, it is desirable that welding be performed from a circumferential part having high tensile stress to a circumferential part having low tensile stress.

[0040] Next, disk forming is performed on the raw material ring having no edge, the approximately cone disk spring (ring spring) is obtained (step S4). Practically, by flattening the raw material ring having no edge into an approximately oblate condition having a certain thickness by hot or cold press forming, the approximately cone disk spring is obtained. It should be noted that the wave spring (ring spring) can be obtained by performing wavy formation by cold or hot pressing, instead of by disk formation. For example, in a case in which wave spring 2 shown in Fig. 3 is produced, it is desirable that mountain part 31 and valley part 32 be formed at a position different from the welded metal part 33.

[0041] Next, if necessary, strain can be removed (step S5) by performing low-temperature annealing on the ring spring (disk spring or wave spring). The low-temperature annealing is performed at 250 °C for 60 minutes, for example. It should be noted that temperature or time for heating can be controlled, if necessary. In the case in which the ring spring is used in hot condition, low-temperature annealing is desirable since deformation can be controlled.

[0042] The ring spring produced in this Embodiment is obtained by welding both edge parts of the raw material, and the ring spring has the welded metal part and the welded heat-affected zone. In this case, since tensile strength is 1000 MPa or more in the condition in which the ring spring has the welded metal part and the welded heat-affected zone, being of sufficient tensile strength as a disk spring and a wave spring, quenching and tempering are not necessary. Therefore, production cost can be reduced. As a result, price of the product can be reduced. Furthermore, since quenching and tempering are not performed, as a result of preventing the product from being deformed, dimensional accuracy of the product can be improved.

[0043] The present invention was explained as above by way of an Embodiment, but the present invention is not limited to the above Embodiment, and variations are possible. For example, in the method for producing the ring spring, shot peening can be performed on the ring spring to obtain compressive residual stress and barrel polishing can be performed on the ring spring to improve surface cleanliness, if necessary. In addition, in a case in which a disk spring is produced as a ring tabular spring, multiple convex parts (nail parts) can be arranged on an inner or outer circumferential part of the main body of the disk spring. With respect to usage configuration of the disk spring, a single disk spring can be used, or multiple disk springs can be used arranged in series or in parallel. In the case in which multiple disk springs are used, for example, disk springs can be welded in order to prevent misalignment of positions.

Examples

[0044] Hereinafter the Embodiment of the invention is further explained with reference to practical Examples.

[0045] In the Examples, disk springs were produced using kinds of raw materials each having chemical composition, carbon equivalent Ceq, (unit: mass%), hardness (unit: HV), and tensile strength (TS before welding, unit: MPa) shown in Table 1. Durability test of each disk spring was performed so that it could be determined whether it passed or failed the test.

Table 1

	Component (mass%)						TS before welding (MPa)	Hardness (HV)	Carbon equivalent (mass%)
	C	Si	Mn	Cr	P	S			
Comparative Example A	0.2	0.88	1.49	0.94	0.015	0.012	917	292	0.67
Example B	0.2	0.88	1.49	0.94	0.015	0.012	1491	480	0.67
Example C	0.2	0.88	11.49	0.94	0.015	0.012	1686	530	0.67
Example D	0.21	1.6	1.6	1	0.013	0.011	1710	535	0.74
Comparative Example E	0.85	0.23	0.3	0	0.015	0.014	1318	420	0.91
Comparative Example F	0.62	0.27	0.51	0	0.016	0.015	1755	555	0.72
Comparative Example G	0.16	0.26	0.44	0	0.012	0.01	449	155	0.24
Comparative Example H	0.44	0.24	0.8	0	0.014	0.012	791	256	0.58
Comparative Example I	0.31	0.4	0.6	0.55	0.014	0.013	1150	365	0.54
Example J	0.17	0.8	1.4	0.9	0.016	0.014	1395	455	0.62
Example K	0.1	0.85	1.2	0.9	0.012	0.01	1102	352	0.52

[0046] Practically, with respect to all the samples A to K, raw material (width: 7 mm, thickness: 1.5 mm) was processed by bending formation so as to obtain raw material rings (outer diameter: 100 mm). In this case, both edge parts of the raw material were brought into facing condition. Next, the facing part was welded by laser so as to obtain a raw material ring having no edge, and a disk spring (free height: 2.5 mm) was produced by performing cold disk formation on the raw material ring. Conditions of production of the samples such as bending formation, laser welding, and disk formation were all the same except that chemical composition or like of the raw material were different, as shown in Table 1.

[0047] With respect to the disk springs of all the samples A to K, tensile strength (TS after welding, unit: MPa) was measured and durability test was performed. The results are shown in Table 2. In the durability test, a displacement control type fatigue testing machine was used, and the disk spring was oscillated from a free height to a fitting height. With respect to the durability test results shown in Table 2, a sample that was not broken at 100,000 times was regarded as having passed (O), and a sample that was broken was regarded as having failed (X). With respect to the broken samples, its broken origin is shown, whether the ring was broken at the "heat-affected zone" or "welded metal".

Table 2

	TS after welding (MPa)	Durability test result	Breaking origin
Comparative Example A	870	×	Heat-affected zone
Example B	1441	○	-
Example C	1620	○	-
Example D	1600	○	-
Comparative Example E	640	×	Welded metal
Comparative Example F	750	×	Welded metal
Comparative Example G	432	×	Heat-affected zone
Comparative Example H	653	×	Welded metal
Comparative Example I	920	×	Welded metal
Example J	1310	○	-
Example K	1045	○	-

[0048] As shown in Table 1, Examples B, C, D, J, and K of the present invention that were produced using raw material having chemical composition, carbon equivalent, hardness and TS before welding within the range of the present invention as shown in Table 1 were not broken during the durability test and exhibited tensile strength of 1000 MPa or more, as shown in Table 2.

[0049] On the other hand, all of the Comparative Examples A, E, F, G, H, and I were broken during the durability test and exhibited tensile strength after welding of less than 1000 MPa. Comparative Examples A and G have content amount of C of less than 0.3 mass%; however, they were considered to be broken at the welded heat-affected part because hardness of the raw material (master material) was low, being less than 350 HV, and had originally low strength, and further decreased in strength by influence of heat.

[0050] With respect to Comparative Examples E, F, H, and I, it is considered that the content of C was over 0.3 mass%, hardness of the welded metal part was too great, toughness was decreased, and thereby they soon exhibited fatigue failure and broke at the welded metal part.

[0051] As explained, it was confirmed that the ring spring that is produced using raw material having the chemical composition, carbon equivalent, hardness and tensile strength before welding within the range of the present invention exhibits high strength with a tensile strength of 1000 MPa or more even without performing quenching.

Claims

1. A ring spring formed to have no edge by welding two edges of a raw material, comprising:

a welded metal part formed at an interface of the two edges of the raw material, and
a welded heat-affected zone formed at the circumference of the welded metal part and which is heated by welding, wherein tensile strength is 1000 MPa or more,
characterized in that the raw material consisting of C: 0.10 to 0.30 mass%, Si: 0.50 to 2.10 mass%, Cr: 0.50 to 1.50 mass%, Mn: 1.0 to 2.0 mass%, P: 0.025 mass% or less, S: 0.025 mass% or less, Fe as a remainder and inevitable impurities and having carbon equivalent Ceq shown by Formula (1) below of 0.5 to 0.75 mass% and hardness of 350 HV or more, wherein brackets indicate mass%, and wherein

$$Ceq = [C] + [Mn] / 6 + [Si] / 24 + [Ni] / 40 + [Cr] / 5 + [Mo] / 4 + [V] / 14 \quad (1).$$

2. The ring spring according to claim 1, wherein a welding start part of the welded metal part is formed at one of an outer circumferential part or an inner circumferential part having higher tensile stress than the other.

3. The ring spring according to claim 1 or 2, wherein the ring spring is a disk spring having a disk shape or a wave spring having a wavy shape consisting of a mountain and a valley.

4. The ring spring according to claim 3, wherein the mountain and the valley are formed at a position different from the welded metal part.

5. A method for producing a ring spring, the method comprising steps of:

a bending forming process in which raw material is formed in approximately a ring shape by bending forming,
a welding process in which edge parts of the raw material of the approximately ring shape are mutually welded so as to obtain a raw material ring having no edge,
wherein in the welding process, a welded metal part is formed at an interface of the two edge parts of the raw material, and a welded heat-affected zone that is heated by welding is formed around the welded metal part, and wherein the ring spring has tensile strength of 1000 MPa or more,
characterized in that the raw material consisting of C: 0.10 to 0.30 mass%, Si: 0.50 to 2.10 mass%, Cr: 0.50 to 1.50 mass%, Mn: 1.0 to 2.0 mass%, P: 0.025 mass% or less, S: 0.025 mass% or less, Fe as a remainder and inevitable impurities and having carbon equivalent Ceq shown by Formula (1) below of 0.5 to 0.75 mass% and hardness of 350 HV or more, wherein brackets indicate mass%, and wherein

$$Ceq = [C] + [Mn]/6 + [Si]/24 + [Ni]/40 + [Cr]/5 + [Mo]/4 + [V]/14 \quad (1).$$

Patentansprüche

1. Ringfeder, die ausgebildet ist, um keine Kante durch das Verschweißen zweier Kanten eines Rohmaterials aufzuweisen, enthaltend:

einen geschweißten Metallabschnitt, der an einer Grenzfläche von zwei Kanten des Rohmaterials ausgebildet ist, und
einen geschweißten, wärmebeeinflussten Bereich, der am Umfang des geschweißten Metallabschnitts ausgebildet ist und durch Schweißen erhitzt wird,
wobei die Zugfestigkeit 1000 MPa oder mehr beträgt,
dadurch gekennzeichnet, dass das Rohmaterial aus C: 0,10 bis 0,30 Massen-%, Si: 0,50 bis 2,10 Massen-%, Cr: 0,50 bis 1,50 Massen-%, Mn: 1,0 bis 2,0 Massen-%, P: 0,025 Massen-% oder weniger, S: 0,025 Massen-% oder weniger, Fe als Rest und unvermeidbaren Verunreinigungen besteht und ein Kohlenstoffäquivalent Ceq, nachstehend ausgedrückt durch Formel (1), von 0,5 bis 0,75 Massen-% und eine Härte von 350 HV oder mehr aufweist, wobei die eckigen Klammern die Massen-% kennzeichnen, und wobei

$$Ceq = [C] + [Mn]/6 + [Si]/24 + [Ni]/40 + [Cr]/5 + [Mo]/4 + [V]/14 \quad (1).$$

2. Ringfeder nach Anspruch 1, wobei ein Schweißstartabschnitt des geschweißten Metallabschnitts an entweder einem äußeren Umfangsabschnitt oder einem inneren Umfangsabschnitt mit einer höheren Zugfestigkeit als der andere ausgebildet ist.

3. Ringfeder nach Anspruch 1 oder 2, wobei die Ringfeder eine Scheibenfeder mit einer Scheibenform oder eine Wellenfeder mit einer welligen Form bestehend aus einem Berg und einem Tal ist.

4. Ringfeder nach Anspruch 3, wobei der Berg und das Tal an einer Position, die verschieden von dem geschweißten Metallabschnitt ist, ausgebildet sind.

5. Verfahren zum Herstellen einer Ringfeder, wobei das Verfahren die Schritte enthält:

einen Biegeformvorgang, in welchem das Rohmaterial in einer annähernden Ringform durch Biegeformen ausgebildet wird,
einen Schweißvorgang, in welchem Kantenabschnitte des Rohmaterials der annähernden Ringform wechselseitig verschweißt werden, um einen Rohmaterialring ohne Kanten zu erhalten,
wobei in dem Schweißvorgang ein geschweißter Metallabschnitt an einer Grenzfläche der zwei Kantenabschnitte des Rohmaterials ausgebildet wird, und ein geschweißter, wärmebeeinflusster Bereich, der durch Schweißen erhitzt wird, um den geschweißten Metallabschnitt herum ausgebildet wird, und
wobei Ringfeder eine Zugfestigkeit von 1000 MPa oder mehr aufweist,
dadurch gekennzeichnet, dass das Rohmaterial aus C: 0,10 bis 0,30 Massen-%, Si: 0,50 bis 2,10 Massen-%, Cr: 0,50 bis 1,50 Massen-%, Mn: 1,0 bis 2,0 Massen-%, P: 0,025 Massen-% oder weniger, S: 0,025 Massen-% oder weniger, Fe als Rest und unvermeidbaren Verunreinigungen besteht und ein Kohlenstoffäquivalent Ceq, nachstehend ausgedrückt durch Formel (1), von 0,5 bis 0,75 Massen-% und eine Härte von 350 HV oder mehr aufweist, wobei die eckigen Klammern die Massen-% kennzeichnen, und wobei

$$Ceq = [C] + [Mn] / 6 + [Si] / 24 + [Ni] / 40 + [Cr] / 5 + [Mo] / 4 + [V] / 14 \quad (1).$$

Revendications

1. Ressort annulaire formé pour n'avoir aucun bord par soudage de deux bords d'une matière première, comprenant :

une partie métallique soudée formée au niveau d'une interface des deux bords de la matière première, et
une zone affectée par la chaleur, soudée, formée au niveau de la circonférence de la partie métallique soudée et qui est chauffée par soudage,
dans lequel la résistance à la traction est de 1 000 MPa ou plus,
caractérisé en ce que la matière première est constituée de C : 0,10 à 0,30 % en masse, de Si : 0,50 à 2,10 % en masse, de Cr: 0,50 à 1,50 % en masse, de Mn : 1,0 à 2,0 % en masse, de P : 0,025 % en masse ou moins, de S : 0,025 % en masse ou moins, de Fe en tant que reste et des impuretés inévitables et a un équivalent carbone Ceq représenté par la Formule (1) ci-dessous de 0,5 à 0,75 % en masse et une dureté de 350 HV ou plus, les parenthèses indiquant des % en masse, et dans lequel

$$Ceq = [C] + [Mn] / 6 + [Si] / 24 + [Ni] / 40 + [Cr] / 5 + [Mo] / 4 + [V] / 14 \ (1).$$

2. Ressort annulaire selon la revendication 1, dans lequel une partie de début de soudage de la partie métallique soudée est formée au niveau de l'une d'une partie circonférentielle externe ou d'une partie circonférentielle interne ayant une contrainte de traction supérieure à celle de l'autre.

3. Ressort annulaire selon la revendication 1 ou 2, le ressort annulaire étant un ressort à disque ayant une forme de disque ou un ressort ondulé ayant une forme ondulée constituée d'une montagne et d'une vallée.

4. Ressort annulaire selon la revendication 3, dans lequel la montagne et la vallée sont formées à une position différente de la partie métallique soudée.

5. Procédé de production d'un ressort annulaire, le procédé comprenant les étapes de :

un procédé de formage par cintrage dans lequel une matière première est approximativement formée en forme d'anneau par formage par cintrage,
un procédé de soudage dans lequel des parties de bord de la matière première de la forme approximativement annulaire sont mutuellement soudées de façon à obtenir un anneau de matière première n'ayant pas de bord,
dans lequel, dans le procédé de soudage, une partie métallique soudée est formée au niveau d'une interface des deux parties de bord de la matière première, et une zone affectée par la chaleur, soudée, qui est chauffée par soudage est formée autour de la partie métallique soudée, et
dans lequel le ressort annulaire a une résistance à la traction de 1 000 MPa ou plus,
caractérisé en ce que la matière première est constituée de C : 0,10 à 0,30 % en masse, de Si : 0,50 à 2,10 % en masse, de Cr: 0,50 à 1,50 % en masse, de Mn : 1,0 à 2,0 % en masse, de P : 0,025 % en masse ou

moins, de S : 0,025 % en masse ou moins, de Fe en tant que reste et des impuretés inévitables et a un équivalent carbone Ceq représenté par la Formule (1) ci-dessous de 0,5 à 0,75 % en masse et une dureté de 350 HV ou plus, les parenthèses indiquant des % en masse, et dans lequel

$$Ceq = [C] + [Mn] / 6 + [Si] / 24 + [Ni] / 40 + [Cr] / 5 + [Mo] / 4 + [V] / 14 \quad (1).$$

Fig. 1

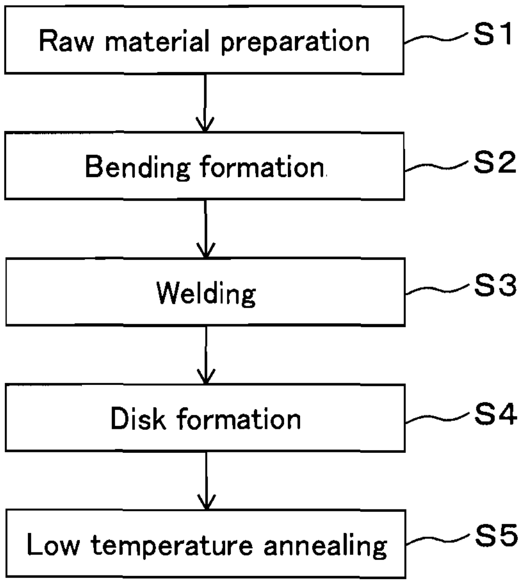


Fig. 2A

Fig. 2B

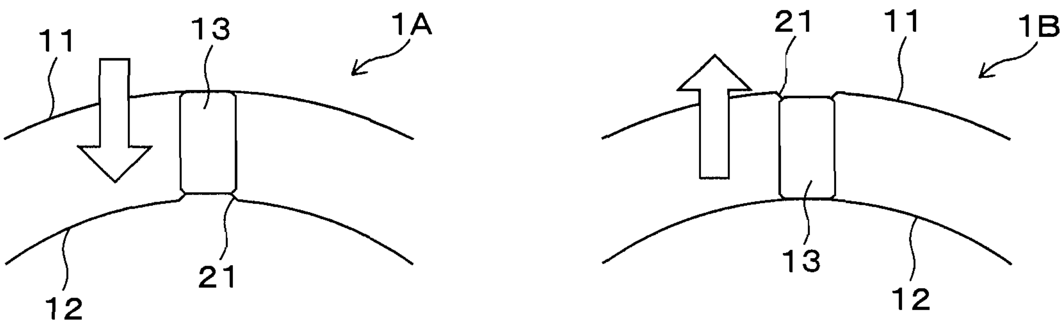


Fig. 3

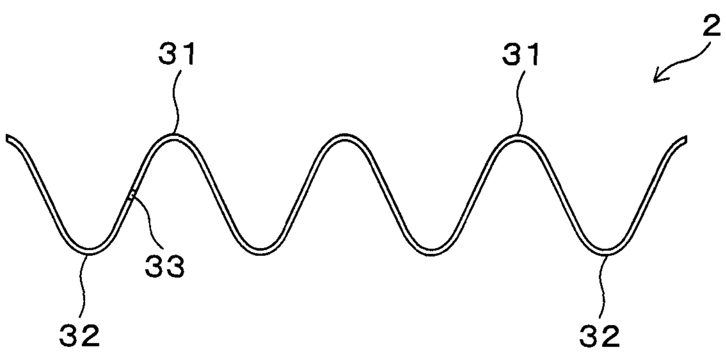
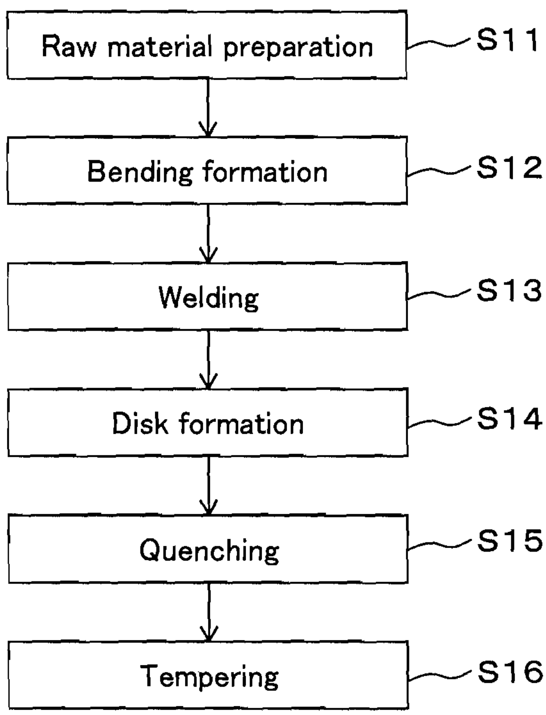


Fig. 4


Raw material preparation
S11
Bending formation
S12
Welding
S13
Disk formation
S14
Quenching
S15
Tempering
S16

REFERENCES CITED IN THE DESCRIPTION

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